CLAIMS

1. A hologram color filter having a function of a color filter that diffraction-separates an incident lightwave using a hologram to project thus separated lightwaves having different wavelengths at intended positions with a specified spatial period, the hologram color filter comprising:

(a) a light-transmitting substrate (21); and

(b) a light-transmitting diamond-like-carbon (DLC) film (22) formed on the substrate;

in the DLC film, a relatively-high-refractive-index belt-shaped region (n_2, 22b) and a relatively-low-refractive-index belt-shaped region (n_1, 22a) being placed alternately.

2. A hologram color filter as defined by claim 1, wherein the variation in diffraction efficiency with respect to the incident lightwave is at most 40% in a wavelength range from a wavelength of 470 μm in the blue-color-light region to a wavelength of 630 μm in the red-color-light region.

3. A hologram color filter as defined by claim 1, the hologram color filter being capable of creating a mutual difference of at least 30% in diffraction efficiency with respect to an s-polarized lightwave and a p-polarized lightwave in a wavelength range from a wavelength of 470 μm in the blue-color-light region to a wavelength of 630 μm in the red-color-light region.

4. A hologram color filter as defined by claim 1, the hologram color filter further comprising a microlens array to which the DLC film is combined;

10. A hologram color filter as defined by claim 1, wherein the boundary region between the low-refractive-index belt-shaped region and the high-refractive-index belt-shaped region is slanted with respect to the direction of the thickness of the DLC film.

11. A method of producing a hologram color filter as defined by claim 1, wherein the DLC film is formed by plasma CVD.

12. A method of producing a hologram color filter as defined by claim 11, wherein the relatively-high-refractive-index regions in the DLC film are formed by treating the DLC film with any one method selected from the group consisting of an ultraviolet-light irradiation, an x-ray irradiation, a synchrotron-radiation-light irradiation, an ion-beam irradiation, and an electron-beam irradiation.

13. A method of producing a hologram color filter as defined by claim 12, wherein the relatively-high-refractive-index regions (22b) in the DLC film (22) are formed by the exposure to ultraviolet rays having a periodical intensity distribution, the ultraviolet rays being obtained by the interference between two types of diffracted lightwaves having passed through a phase grating mask (24c).

14. A color liquid-crystal-display unit, comprising:

(a) a hologram color filter as defined by claim 1; and

(b) a liquid crystal panel coupled with the hologram color filter;

the spatial period corresponding to the period of a plurality of pixels included in the liquid crystal panel.

in the DLC film, the width and spacing of the high-refractive-index belt-shaped regions being predetermined on a fixed basis;

the microlens array comprising a plurality of microlenses placed at a period corresponding to the spatial period.

5. A hologram color filter as defined by claim 1, wherein the width and spacing of the high-refractive-index belt-shaped regions are varied periodically corresponding to the spatial period to combine a light-separating function and a microlens-array function.

6. A hologram color filter as defined by claim 1, the hologram color filter further comprising at least one DLC film;

each of the DLC films having a peak of diffraction efficiency for a lightwave having a wavelength different with each other.

7. A hologram color filter as defined by claim 6, wherein:

(a) the DLC films comprise a first DLC film and a second DLC film; and

(b) the first DLC film has a peak of diffraction efficiency for a red-color lightwave, and the second DLC film has a peak of diffraction efficiency for a blue-color lightwave.

8. A hologram color filter as defined by claim 1, wherein the refractive index is varied in multiple stages in the boundary region from the low-refractive-index belt-shaped region to the high-refractive-index belt-shaped region.

9. A hologram color filter as defined by claim 1, wherein the refractive index is varied continuously in the boundary region from the low-refractive-index belt-shaped region to the high-refractive-index belt-shaped region.

15. A color liquid-crystal-display unit as defined by claim 14, wherein:

(a) each of the pixels includes a red-color-displaying region, a green-color-displaying region, and a blue-color-displaying region; and

(b) the hologram color filter separates the incident lightwave into a red-color lightwave, a green-color lightwave, and a blue-color lightwave to project them to the red-color-displaying region, the green-color-displaying region, and the blue-color-displaying region, respectively.

16. A color liquid-crystal-display unit as defined by claim 14, the color liquid-crystal-display unit further comprising dichroic mirrors that separate a lightwave from a white-color light source into a red-color lightwave, a green-color lightwave, and a blue-color lightwave to give them to the hologram color filter as incident lightwaves;

each of the pixels including a red-color-displaying region, a green-color-displaying region, and a blue-color-displaying region;

the hologram color filter projecting the red-color lightwave, the green-color lightwave, and the blue-color lightwave, all separated from the incident lightwave, to the red-color-displaying region, the green-color-displaying region, and the blue-color-displaying region, respectively.

17. A color liquid-crystal-display unit as defined by claim 14, the color liquid-crystal-display unit further comprising as a light source any one light source selected from the group consisting of a halide lamp, a superhigh-pressure mercury lamp, a cold cathode-ray tube, a xenon lamp, a light-emitting diode, and a laser.

18. A color liquid-crystal-display unit, comprising:

(a) any one member selected from the group consisting of a plurality of light-emitting diodes and a plurality of lasers (91B, 91G, and 91R), the member being for emitting a blue-color lightwave, a green-color lightwave, and a red-color lightwave individually;

(b) a hologram color filter (84a) comprising a DLC film (22); and

(c) a liquid crystal panel (85-89) comprising a plurality of pixels arranged with a specific spatial period;

in the DLC film (22), a relatively-high-refractive-index belt-shaped region (n_2, 22b) and a relatively-low-refractive-index belt-shaped region (n_1, 22a) being formed alternately;

the width and spacing of the high-refractive-index belt-shaped regions being varied periodically corresponding to the spatial period of the pixels.

19. A method of producing a color liquid-crystal-display unit as defined by claim 18, wherein the relatively-high-refractive-index regions (n_2, 22b) in the DLC film (22) are formed by the exposure to ultraviolet rays having a periodical intensity distribution, the ultraviolet rays being obtained by the interference between two types of diffracted lightwaves having passed through a phase grating mask (24c).